M/035/015

ATTACHMENT A

Application for Permit Renewal: Tailings Impoundment Ground Water Discharge Permit #UGW350011

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DIV OF OIL GAS & MINING

ASSESSMENT OF COMPLIANCE WELLS
APPLICATION FOR RENEWAL FOR THE TAILINGS IMPOUNDMENT
Groundwater Discharge Permit #UGW350011
JULY 2005

EXECUTIVE SUMMARY

Over the past five years Kennecott Utah Copper Corporation tailings impoundment has performed well with respect to ground water compliance. Many of the compliance wells have maintained compliance within established permit limits and have shown very little to no impacts from tailings operations over the past ten years of monitoring. This is largely attributed to the neutral pH conditions throughout most of the impoundment, upward hydraulic gradients as well as the performance of the low permeability Bonneville clay underlying the tailings impoundment. The following is a summary of data over the past ten years:

- All thirty-two tailings ground water compliance wells have maintained neutral to slightly alkaline pH levels.

- Sodium and chloride concentrations comprise the large majority of total dissolved solids (TDS) in all wells, between 50% and 95%, indicating the Great Salt Lake and/or fresh water recharge in the area has the highest impact on water quality.

- In all thirty-two groundwater monitor wells, concentrations of copper, lead and zinc have largely remained below the limit of detection over the past ten years.

- Twenty-three of the thirty-two wells have not experienced any noticeable change in water quality over the past ten years. Six of the thirty-two wells have displayed an improvement in water quality through decreasing concentrations of sulfate, while only three of the thirty-two wells have displayed slight declines in water quality, mostly attributed to increases in sulfate or arsenic.

1 INTRODUCTION

A groundwater discharge permit for the Tailings Impoundment was granted by the State of Utah Division of Water Quality (DWQ), Department of Environmental Quality, to Kennecott Utah Copper Corporation (KUCC) effective January 6th, 2001. This document report provides the results of compliance well monitoring and analyzes the trends in the data.

A monitor network of thirty-two wells was initially established to monitor the performance of the Kennecott Tailings Impoundment. The primary objective of these wells is to measure any water quality impact that may occur to the shallow unconfined and principal aquifer system from tailings operations. Permit limits were established after the collection of two years worth of data.

Each well is sampled semi-annually and they have a sampling history dating back more than a decade. Notable trends in the data are discussed below on a well by well basis. Refer to Map ENV-MT-015 for the location of the wells.

Elevated concentrations of sulfate and metals are indicators of tailings impacted waters and a well will typically show elevated or increasing concentrations of these parameters above established permit limits as a volume of mine impacted water moves through the geologic unit.

Sodium and chloride are good indicators of freshwater recharge or impacts from the Great Salt Lake. Those wells that have been minimally or not at all impacted by mine waters, typically have elevated sodium and chloride concentrations (indicator of meteoric waters) that make up the majority of TDS in the well (>60%). These wells also have low and relatively constant concentrations of sulfate, with metals concentrations that are low or less than the limit of detection.

In some areas, there are numerous wells, many of which are located in close proximity. It has been proposed that some of these wells be omitted due to the redundancy in sampling data and concentrations constituents have remained relatively unchanged for the past ten years.

2 COMPLIANCE MONITORING WELLS

All available data along with a statistical analysis for the 32 compliance wells can be found in attached Tables 2.1, 2.2 and 2.3. Additional discussion of trends in compliance monitoring wells can be found in the quarterly compliance and annual monitoring reports.

2.1 WELLS PROPOSED TO REMAIN IN COMPLIANCE MONITORING NETWORK

The following is a discussion of tailings compliance wells that may have been impacted by tailings operations. Although many of these wells have not shown any substantial change in water quality over the past ten years, and permit limits have been met, concentrations of sulfate or metals have remained slightly elevated.

NEL532A – This well is located on the east side of the south impoundment. Although sodium and chloride comprise 92% of the TDS observed in the well, the well may be showing some minor impacts from tailings operations. Sulfate in the well has been slowly increasing over the past ten years from approximately 180 mg/L in 1992 to 993 mg/L by the end of 2004. However, concentrations have declined through 2005 and are now 546 mg/L. The increase in concentrations may have been due to lack of fresh water recharge between 1999 and 2004. Although concentrations of copper, lead and zinc have remained less than the limit of detection, and arsenic has maintained permit limits for the past ten years and averages 183 ug/L. KUCC proposes to keep this well as a measure of compliance.

NEL532B – This well is located on the east side of the south impoundment. This well has always shown minimal to no impacts from tailings operations with sulfate averaging only 49 mg/L and sodium and chloride comprising the majority of TDS (87%). Arsenic concentrations have largely remained within the limits of compliance and relatively unchanged over the past ten years with an average of 209 ug/L. KUCC proposes to keep this well as a measure of compliance.

NEL1382A – This well is located on the east side of the south impoundment. Concentrations of copper, lead and zinc are less than detection, sodium and chloride comprise the majority of TDS in the well (89%) and sulfate levels have remained relatively low and unchanged over the past ten years. Arsenic concentrations have averaged 199 ug/L and have largely maintained levels within compliance limits established for the well. KUCC proposes to keep this well as a measure of compliance.

NEL1382B&C – These wells are located on the east side of the south impoundment screened below NEL1382A. Similar to NEL1382A, sodium and chloride make up greater than 70% of the TDS in the well and concentrations of copper, lead and zinc have remained less than the limit of detection. Both wells have shown minimal impacts from sulfate with average concentrations of 70 mg/L and 64 mg/L for NEL1382B and NEL1382C respectively. Arsenic concentrations have remained relatively unchanged and have maintained compliance with established permit limits with averages of 317 ug/L for NEL1382B and 450 ug/L for NEL1382C. KUCC proposes that these wells remain on the list of compliance wells.

NET1381A&B - These wells are located on the south east section of the north impoundment, near the east abutment. In both wells sodium and chloride comprise the majority of TDS (82% for NET1381A and 85% for NET1381B) and concentrations of copper, lead and zinc are all below the limit of detection. Concentrations of arsenic and sulfate have remained relatively low and unchanged over the past ten years in NET1381A, with levels of 273 mg/L and 47 ug/L respectively. Similarly, arsenic concentrations in NET1381B have also remained relatively unchanged over the past ten years, although sulfate concentrations have averaged 848 mg/L. Apart from an isolated increase in NET1381A on 10/14/2004 to 69 ug/L, compared to a compliance limit of 67 ug/L, both NET1381A&B have maintained compliance with respect to arsenic. KUCC proposes to keep these wells as measures of compliance.

NET1383A&B – These wells are located on the north east corner of the north impoundment. Sodium and chloride comprise the majority of TDS in both wells (95%). The average sulfate concentration have remained relatively low and unchanged in both wells (between 187 mg/L and 219 mg/L) and concentrations of copper, lead and zinc have remained below the limit of detection. Arsenic has remained relatively unchanged and within established permit limits for both wells over the past ten years. KUCC proposes that these wells remain as part of the compliance monitor well network.

NET1384A&B – These wells are located on the north side of the north impoundment. Concentrations of all metals have maintained compliance with established limits and

remained low or less than detection for the past ten years, and sodium and chloride comprise the majority of TDS in both wells (90%). The well has shown historical impacts from sulfate. In 1996 sulfate concentrations in NET1384A were approximately 14,000 mg/L, however by the fourth quarter 2004, concentrations declined to 2800 mg/l. Sulfate in NEL1384B has maintained a relatively constant level of 2100 mg/L since 1996. KUCC proposes to keep these wells as part of the compliance monitoring network.

NET646A&B - These wells measure compliance along the north west side of the north impoundment. Although concentrations of all metals have remained low or less than detection for the past ten years, and sodium and chloride comprise the majority of TDS in both wells (between 87 and 94%) the well has shown historical impacts from sulfate. In 1996 sulfate concentrations in NET646A were approximately 7,500 mg/L. Since 1996 concentrations have been steadily declining and reached a level of approximately 1,000 mg/l by the fourth quarter 2004. Sulfate in NEL646B has maintained a relatively constant level of 1,200 mg/L since 1996. KUCC proposes to keep these wells as part of the compliance monitoring network.

NET1393A&B – These wells are located on the western most section of the north impoundment. Concentrations of sulfate and all metals in both wells have remained very low or less than the limit of detection over the past ten years and show minimal impacts from tailings operations. In addition, these wells have been analyzed for uranium, radium 226, radium 228, gross alpha and gross beta for the past five years due to historic phospho-gypsum operations not related to KUCC. Concentrations of uranium, radium-226 and radium-228 have remained low or less than the limit of detection. It is likely that uranium concentrations are not high enough to produce any substantial amount of radium. KUCC proposes to keep these wells as part of the monitoring network with the omission of radium 226, radium 228, gross alpha and gross beta analysis unless uranium levels are elevated above the limit of detection.

NET1380A – This well is located on the western most section of the south impoundment. Over the past ten years concentrations of all metals have remained less than the limit of detection and sodium and chloride concentrations comprise the majority of TDS in the well at 67%. Sulfate concentrations in the well are elevated and have averaged 558 mg/L over the past ten years. KUCC proposes keeping this well as part of the compliance monitor well network.

NET1491 and NET1492 – These wells are located on the south west section of the South Tailings Impoundment. Concentrations of all metals in both wells have remained very low or less than the limit of detection for the past ten years and sodium and chloride concentrations comprise the majority of TDS in both wells (63%). Sulfate concentrations in both wells have been declining over the past ten years. In 1999, sulfate concentrations increased to approximately 750 mg/L and 800 mg/L respectively for NET1491 and Net1492. Sulfate has been steadily declining and concentrations measured in the first quarter 2005 in NET1491 are 299 mg/L, while concentrations in NET1492 are 340 mg/L. KUCC proposes that these wells remain as part of the compliance monitoring network.

NED604A&B – These wells are located to the east side of the South Impoundment on the south side of HWY 201 in an area called the Diving Board. Sodium and chloride comprise the majority of TDS in both wells and copper, lead and zinc have maintained levels below the detection limit. Although average arsenic concentrations are relatively low in both wells, concentrations have been increasing slightly in NED604A. In addition, sulfate concentrations are slightly elevated in NED604A. KUCC proposes that these wells remain as part of the compliance monitoring network.

NEM1387 – This well is located on the east side of the south tailings impoundment near the tailings clarification canal. Sodium and chloride concentrations comprise the majority of TDS measured in the well, arsenic concentrations have remained consistently low (24 ug/L) and concentrations of copper, lead and zinc have remained below the limit of detection. Over the past ten years, sulfate levels have declined slightly from 330 mg/L in 1996 to less than 290 mg/L by 2004. KUCC proposes to keep this well as part of the compliance monitoring network.

NEL536A – This well is one of three wells located on the south east corner of the south impoundment. Although sulfate concentrations have remained relatively unchanged over the past ten years, levels have been slightly elevated, averaging 322 mg/L. Apart from slightly elevated sulfate this well shows very minimal impacts. Concentrations of all metals have remained relatively low or less than the limit of detection over the past ten years and sodium and chloride concentrations comprise 60% of the TDS in the well. KUCC proposes to keep this well as part of the compliance monitoring network.

2.2 WELLS SHOWING NO IMPACTS PROPOSED TO BE REMOVED FROM COMPLIANCE MONITORING NETWORK

Table 4.1 contains all tailings compliance wells that have received minimal to no impacts from tailings operations. These wells contain low concentrations of sulfate and arsenic concentrations and on average levels copper, lead and zinc have remained less than the limit detection. Sulfate concentrations remain low (between an average of 2 mg/L and 160 mg/L) and concentrations have not changed in over ten years. In addition, sodium and chloride concentrations make up the largest contribution to TDS in all wells.

Se plume is deep downgradient of refining No Se plume SE wetlands reclamation monitor point.

NET1380B – This well is located on the western most point of the South tailings impoundment, at an area called the west abutment. Over the past ten years, sulfate in the well has only averaged 2 mg/L, while concentrations of arsenic, copper, lead and zinc have all remained less than the limit of detection. Sodium and chloride make up approximately 75% of the TDS in the well. KUCC proposes omitting this well from the compliance list.

NET1386A – This well is located on the western section of the north impoundment. Over the past ten years, sulfate concentrations have remained very low, averaging 23 mg/L. Arsenic concentrations are very low (averaging 12 ug/L), while concentrations of copper, lead and zinc have remained below the limit of detection. Sodium and chloride make up 94% of the TDS in the well. This well has not been impacted by tailings operations and

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what facility was there that is causing monitored

why assessment?

KUCC proposes omitting this well. Well NET1393A is in close proximity to this well and thus sampling in the area is redundant.

93A & B also monitor the same AM? DRC thoughts?

NET1386B – This well is located on the western section of the north impoundment. Over the past ten years sulfate concentrations have remained very low and relatively unchanged (average of 48 mg/L). Similarly, arsenic concentrations have also remained low and unchanged with an average concentration of 43 ug/L. Copper, lead and zinc concentrations have maintained levels less than the limit of detection over the same time period. Sodium and chloride concentrations comprise 95% of the TDS measured, thus the water quality in the well has received very minimal impacts and KUCC proposes omitting this well from the compliance list. Well Net1393B is in close proximity to this well and thus the sampling in the area is redundant.

purpose of well: - interstial pore water w/ hydraulic head from overlying tailings well is deep OK

NET449D – This well is located on the south east corner of the south impoundment. Over the past ten years arsenic concentrations have averaged 40 ug/L and have remained relatively unchanged, while concentrations of copper, lead and zinc have remained less than the limit of detection. Average sulfate concentration is 58 mg/L and sodium and chloride comprise the majority of TDS measured in the well (62%). There are a number of wells located in the area and KUCC proposes omitting is well from the tailings compliance list.

No

NET1385A – This well is screened in alluvial and is located on the north east corner of the north impoundment between NET1383A and NET1381A. Over the past ten years sulfate concentrations have averaged 140 mg/L and have remained largely unchanged. Similarly, arsenic concentrations have also remained relatively low and unchanged over the same time period. Over the past ten years arsenic concentrations have consistently maintained levels less than the permit limits established for the well. Copper, lead and zinc have all remained less than the limit of detection and sodium and chloride comprise the large majority of TDS in the well (91%). KUCC proposes omitting is well from the compliance list.

No

NET1385B – This well is screened in bedrock and is located on the north east corner of the north impoundment between NET383B and NET1381A. Over the past ten years concentrations of both sulfate and arsenic have remained relatively low and unchanged, with average concentrations of 166 mg/L and 139 ug/L respectively. Over the past ten years arsenic concentrations have consistently maintained levels less than the permit limits established for the well. In addition concentrations of copper, lead and zinc have remained below the limit of detection and sodium and chloride comprise the majority of TDS in the well at 94%. Similar to NET1385B, this well demonstrates no measurable impacts by tailings operations and KUCC proposes omitting this well from the compliance list.

Drilled C

NEL536B&C – These wells are screened below NEL536A and located on the south east corner of the South Impoundment. Over the past ten years sulfate concentrations have averaged less than 67 mg/L in both wells and concentrations have remained largely unchanged. Arsenic concentrations have also remained very low and unchanged over the same time period and have averaged 18 ug/L (NEL536B) and 10 ug/L (NEL536C).

Copper, lead and zinc have all remained less than the limit of detection and sodium and chloride comprise the large majority of TDS in the well. KUCC proposes omitting these wells from the compliance list.

2.3 REDUNDANT WELLS PROPOSED TO BE REMOVED FROM COMPLIANCE MONITORING NETWORK

NEL531B – This well is located on the east side of the South Tailings Impoundment. Since 1992, concentrations of sulfate have remained relatively constant and have averaged only 56 mg/L. Sodium and chloride comprise over 80% of the TDS in the well. Arsenic concentrations have averaged 264 ug/L over the past ten years and concentrations have remained relatively unchanged and maintained compliance with established permit limits. Concentrations of copper, lead and zinc have all remained less than the limit of detection. Over the past five years this well has become increasingly more difficult to sample due to a high amount of suspended sediment. This well is often out of compliance with respect to TDS but data as repeatedly shown the increase in TDS is not related to tailings operations, but rather to sodium and chloride conncentrations. The suspended solids are gray in color and resemble bentonite, thus it is likely that the well casing is cracked. There are a number of additional wells in the area that are better indicators of tailings operations. KUCC proposes omitted this well from the compliance list.

consider replacing well

NET1490 – This well is located on the south west section of the South Tailings Impoundment in close proximity with NET1491 and NET1492. Concentrations of arsenic, copper, lead and zinc have all largely remained less than the limit of detection over the past ten years. Although historic sulfate concentrations have been as high as 371 mg/L, concentrations measured in the first quarter 2005 are below 200 mg/L. In addition, sodium and chloride comprise the majority of TDS in the well (63%), indicating very little impact from tailings operations. Since wells NET1491 and NET1492 are in the same area, it would be redundant to sample this well and KUCC proposes omitting this well from the compliance list.

for repository monitoring

3 CONCLUSION

Over the past five years Kennecott Utah Copper Corporation tailings impoundment has performed well with respect to ground water compliance and the large majority of the wells have maintained compliance within established permit limits. Many wells have shown very little to no impacts at all over the past ten years of monitoring and this has been largely attributed to the neutral pH conditions throughout most of the impoundment, upward hydraulic gradients as well as the performance of the low permeability Bonneville clay underlying the tailings impoundment.

In general, all 32 tailings ground water compliance wells have maintained neutral to slightly alkaline pH levels. In addition, sodium and chloride concentrations comprise the large majority of total dissolved solids (TDS) in all wells, between 50% and 95%, indicating the Great Salt Lake and/or fresh water recharge in the area has the highest impact on water quality. In all thirty-two groundwater monitor wells, concentrations of

copper, lead and zinc have largely remained below the limit of detection over the past ten years. Twenty-three out of the thirty-two compliance wells did not show any noticeable change in water quality over the past ten years, while six wells displayed improvements in water quality through decreasing sulfate concentrations.

Based on the trends in water quality for each well, KUCC proposes to change the number of compliance wells in the permit to twenty-two (Table 3.0) and omit ten wells that show very little to no tailings impacts or changes. Those wells that KUCC is proposing to eliminate have very low concentrations of sulfate (indicators of mine-impacted waters) and their concentrations have remained relatively stable for over ten years. Those wells have metals concentrations that have continuously remained low or below the limit of detection, while sodium and chloride concentrations constitute the majority of TDS in the well. In addition, those wells have maintained concentrations well below established compliance limits.